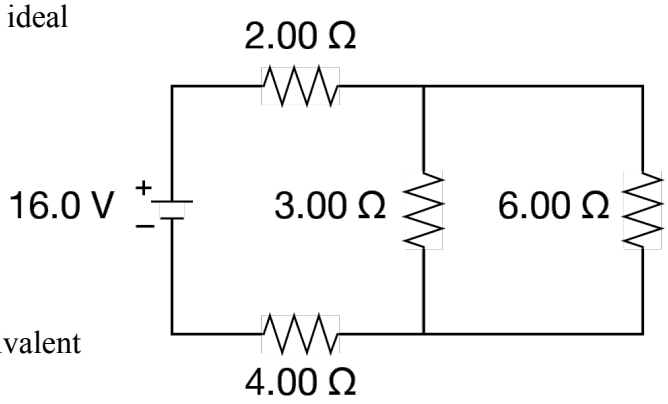
PHYS 1120 Discussion 5:
DC Circuits

Problems

As usual, there is no room on this sheet. Use scratch paper.

1. The circuit to the right comprises one ideal voltage supply and four resistors.



   A. Find the equivalent resistance of the four resistors. (Simplify the four resistors to a single resistor connected across the voltage source that will have the same effect on the battery.)

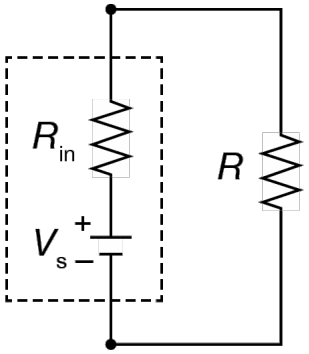
   B. Find the current through the "equivalent resistor."

   C. Once you have found the current through the equivalent resistor, through which two actual resistors is it now easy to find the current?

   D. Now that you've found the current through those two resistors, find the voltage across them.

   E. Now find the voltages across and currents through the other two resistors in the circuit.

2. The "ideal voltage source" depicted in circuit diagrams is an imaginary device that maintains a constant voltage no matter what component it powers. For instance, if a conductor with a very low resistance is placed across its terminals, it must produce a very large current and correspondingly very high power. Real devices, such as batteries, do not produce unlimited power. To be more realistic, batteries are often modeled as a voltage source with "internal resistance," which is drawn as an ideal voltage source in series with a resistor. The structure illustrated to the right is an example of a simple circuit containing such a battery model. The battery model is enclosed in the dashed line.



   A. If the load resistor R is a perfect conductor (zero resistance), how much current would flow from the battery?

   B. Let's say the battery has a voltage $V_s = 6.0$ V and an internal resistance of $R_{in} = 0.20\ \Omega$, and that the load resistor $R = 0.001\ \Omega$.

      a. What current flows through the load resistor?

b. What is the voltage across the load resistor?

c. What is the power dissipated by the load resistor?

d. What is the power dissipated inside the battery? (This is the power dissipated by R_{in}.)

C. Let's now continue with the battery model of $V_s = 6.0$ V and $R_{in} = 0.20\ \Omega$, but with a more resistive load R = 1000 Ω.

a. What current flows through the load resistor?

b. What is the voltage across the load resistor?

c. What is the power dissipated by the load resistor?

d. What is the power dissipated inside the battery?

D. It turns out that the most power will be dissipated by the load resistor if its resistance is equal to the internal resistance of the battery. Suppose that now $V_s = 6.0$ V, $R_{in} = 0.20\ \Omega$, and $R = 0.20\ \Omega$.

a. What current flows through the load resistor?

b. What is the voltage across the load resistor?

c. What is the power dissipated by the load resistor?

d. What is the power dissipated inside the battery?

3. This one is for fun. (Problem 18.14 in your Serway textbook.) An ideal voltage source with $\varepsilon = 6.00$ V supplies current to the circuit to the right. When the double-throw switch S is open as shown in the diagram, the current in the voltage source is 1.00 mA. When the switch is closed in position *a*, the current in the battery is 1.20 mA. When the switch is closed in position *b*, the current in the voltage source is 2.00 mA. Find the resistances R_1, R_2, and R_3.